

A NEW SPECIES OF *SIPHOCYPRAEA* (GASTROPODA: CYPRAEIDAE) FROM NORTHERN SOUTH AMERICA WITH NOTES ON THE GENUS IN THE CARIBBEAN

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ABSTRACT

A new cowrie from the southern Caribbean, *Siphocypraea donmoorei* new species, is described. The anatomies and ecologies of the new species and the closely related *Siphocypraea mus* (Linnaeus, 1758) are outlined, and the evolution and distribution of the genus *Siphocypraea* in the Caribbean is discussed.

The genus *Siphocypraea* is one of the oldest living groups of cowries, dating from at least the Eocene. During the Miocene and Pliocene, widespread species complexes developed in Asia and throughout what is now the Caribbean region. By the beginning of the Pliocene, two major species groups had evolved in the Americas: the *S. carolinensis* (Conrad, 1841) complex in the Southeastern United States that became extinct in the upper Pliocene, and the *S. henekeni* complex in the West Indies, the Atlantic and Pacific coasts of Central America, and northern South America (Ingram, 1947, p. 6, Olsson and Petit, 1964, pp. 556-557). The *S. henekeni* species complex is shown in Table 1. Weisbord (1962, pp. 236-237) and Pflug (1961, pp. 30-31) give excellent synonymies for *S. henekeni* and all its varieties and forms.

In recent years, commercial shrimp boats working along the northern South American coast, from Panamá to the Gulf of Venezuela, have collected large numbers of unusual and seldom-seen mollusks. One of these is a remarkable cowrie that closely resembles members of the Pliocene *Siphocypraea henekeni* complex. It now appears that two species of this large complex have survived to the present. These descendants are restricted to northern South American waters, the ancestral center of speciation for the complex, and are discussed herein.

CYPRAEIDAE Gray, 1824
Siphocypraea Heilprin, 1887
(=*Muracypraea* Woodring, 1957)

Type Species by Monotypy.—*Cypraea* (*Siphocypraea*) *problematica* Heilprin, 1887, Caloosahatchee Formation, Pliocene of Southern Florida (Heilprin, 1887, p. 87).

Diagnosis of Genus.—Shells variable in form, most commonly ovate and inflated, with high dorsum. Bulla stage exhibiting characteristic crater-like depression over the apex (Olsson and Petit, 1968, p. 279). Apical sulcus of adults variable, ranging from spiriform as in *S. problematica* to vertical as in *S. mus*. Adults of many *Siphocypraea*, both living and extinct, have two or more large porcellaneous dorsal tuberosities.

Remarks.—Woodring (1957, pp. 88-90) erected *Muracypraea* as a subgenus of *Cypraea*. This was an attempt to bring together the fossil *Siphocypraea henekeni* (Sowerby I, 1850)¹ and all its forms and the living species *S. mus*. However, the

¹ Although named for Colonel Heneken, the shell was inadvertently spelled *henikeri* in the original publication. In 1873, Gabb emended this to *henekeni*. This action has since been supported by Woodring (1959), Weisbord (1962), Olsson and Petit (1968), and other workers.

Table 1. List of Nominal Species in the Neogene *Siphocypraea henekeni* Complex

<i>Siphocypraea amandusi</i> (Hertlein and Jordan, 1927)
<i>Siphocypraea andersoni</i> (Ingram, 1947)
<i>Siphocypraea caroniensis</i> (Maury, 1927)
<i>Siphocypraea cayapa</i> (Pilsbry and Olsson, 1941)
<i>Siphocypraea grahami</i> (Ingram, 1947)
<i>Siphocypraea henekeni</i> (Sowerby, 1850)
<i>Siphocypraea isthmica</i> Schilder, 1927
<i>Siphocypraea lacrimula</i> (Maury, 1925)
<i>Siphocypraea merriami</i> (Ingram, 1939)
<i>Siphocypraea nouelei</i> (Maury, 1917)
<i>Siphocypraea potreronis</i> (Ingram, 1939)
<i>Siphocypraea projecta</i> (Ingram, 1947)
<i>Siphocypraea quagga</i> Schilder, 1939
<i>Siphocypraea rugosa</i> (Ingram, 1947)
<i>Siphocypraea tuberae</i> (Ingram, 1948)

form of the bulla stages of both *S. henekeni* and *S. mus* is indistinguishable from that of *S. problematica*, the type of the genus. It seems unwise to split off the *S. henekeni* complex, or any other siphocypraeen group, as a separate subgenus strictly on morphologically variable adult characteristics.

Siphocypraea mus (Linnaeus, 1758)
(Figures 1A and B)

Simplified Synonymy:

- Cypraea mus* Linnaeus, 1758: 721.
Cypraea carthaginensis Roding, 1798: 22.
Cypraea autumnalis Perry, 1811: Pl. 21.
Cypraea tuberculata Gray, 1828: 85. (Form with a single dorsal tuberosity).
Cypraea maculosa d'Orbigny, 1846: Pl. 15. (*non Cypraea maculosa* Gmelin, 1791 = *Cypraea pyrum* Gmelin, 1791, from the Mediterranean area).
Cypraea bicornis Sowerby 1, 1870. (Form with two dorsal tuberosities).
Cypraea fuscotecta Sullioti, 1924: 26.
Cypraea suta Coen, 1949: 14.

Material Examined.—Adult specimens, lengths 50 mm, 45 mm, 44 mm, 43 mm, 43 mm, 42 mm, 41 mm, 40 mm, 38 mm, 38 mm, 36 mm, 36 mm, intertidal, Amuay Bay, Paraguana Peninsula, Falcon State, Venezuela (11°35'N, 70°15'W), January and March, 1975, May, 1976; subadult specimens, lengths 39 mm and 34 mm, bulla stages, lengths 36 mm, 35 mm, 32 mm and a *bicornis*-calloused variety, length 40 mm, all from Amuay Bay; an adult, length 53 mm, and a subadult, length 48 mm, on beach, Riohacha, Guajira Peninsula, Colombia (11°30'N, 72°45'W), January 1974.

Shell Description.—Shell oval, light-weight, with rounded dorsum; base of shell flattened; aperture only slightly curved, narrow at posterior end, flaring at anterior end; shell brownish-cream overlaid with series of chocolate brown broken bands radiating from mid-dorsal line; mid-dorsal line bordered by two rows of large, dark brown dots. In some specimens, dots fusing to form large blotches over entire dorsum.

Base of shell dark brown with darker mottlings. Outer lip cream-colored with intermittent chocolate bands, each band radiating from one of the labial teeth. Columellar area usually devoid of teeth; some specimens with few teeth at anterior and posterior ends. Center of columella darkly pigmented with large brown blotch. Interior of aperture dark brown. Very old or senile specimens with one, two, three, or more dorsal tuberosities.

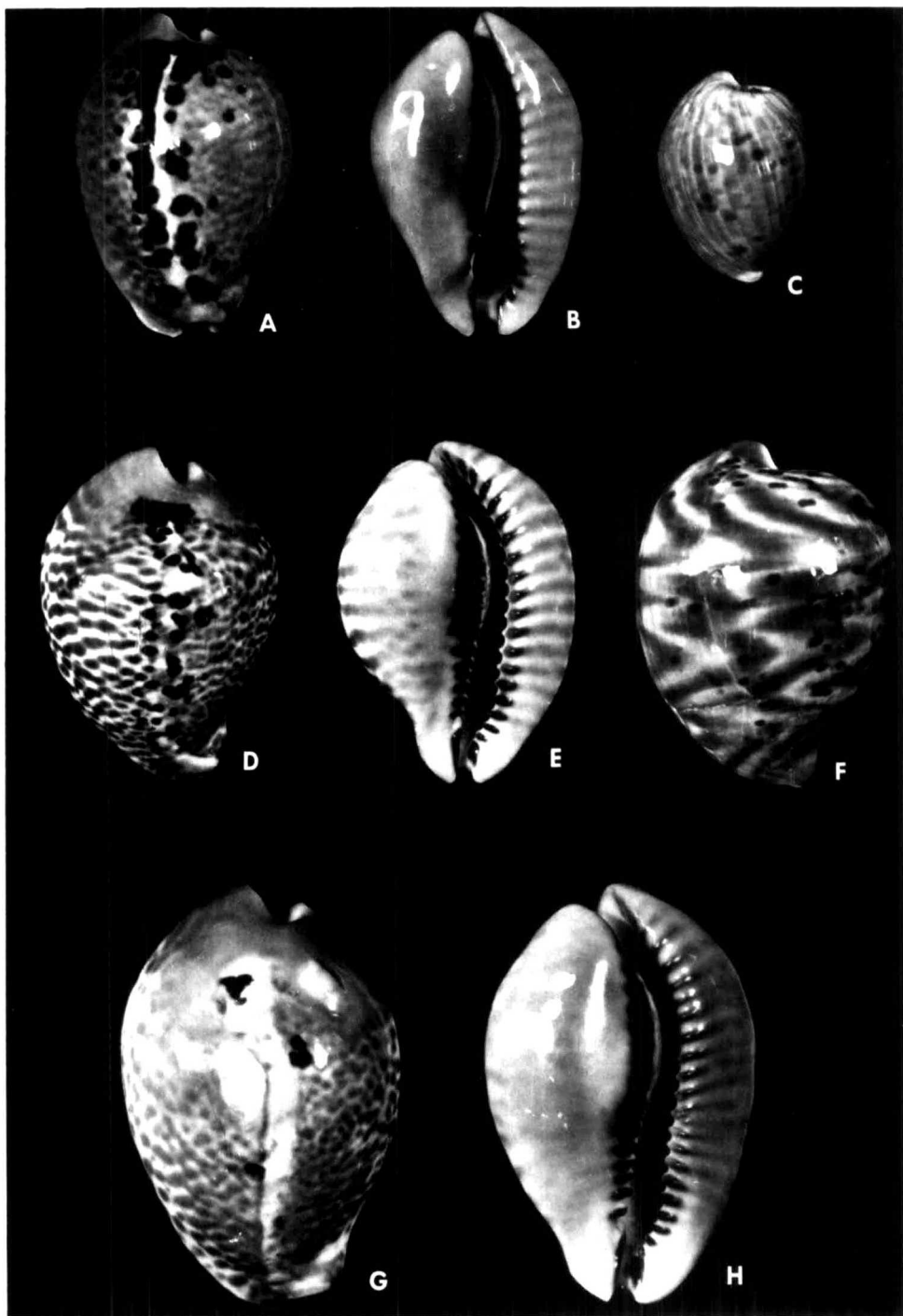


Figure 1. A, *Siphocypraea mus* (Linnaeus, 1758), dorsal aspect of shell, length 51 mm; B, ventral aspect of same specimen; C, *Siphocypraea mus*, bulla stage, length 34 mm; D, *Siphocypraea donmoorei* new species, dorsal aspect of shell, length 52 mm; E, Ventral aspect of same specimen; F, *Siphocypraea donmoorei*, bulla stage, length 54 mm; G, *Siphocypraea donmoorei*, dorsal aspect of holotype, length 64 mm; and H, *Siphocypraea donmoorei*, ventral aspect of holotype.

Description of Soft Parts.—**HEAD.** Cephalic trunk greyish, speckled with black (Fig. 2D). Buccal mass black, covering most of head region when expanded. Eyes darkly pigmented, large (averaging 1.5 mm in diameter for adults), mounted on small pedicels separated from bases of tentacles. Tentacles cream-colored, short, clublike.

MANTLE. Dark grey to cream-colored, covered with large black or grey blotches. (Fig. 2A). Mantle papillae uniform in size over entire mantle (Fig. 2E), conical, averaging 0.5 mm in length. Papillae translucent, cream-colored, with pale orange tips. Viewed against dark background of mantle, papillae resemble tiny, glistening jewels.

FOOT. Broad, greyish-cream and speckled with black, like cephalic region. Dorsal margin of foot with well-developed papillae similar to those on mantle.

GENITALIA. Penis small (average 3 mm), smooth, simple in form. Female genitalia of the *Cypraea mauritiana*—type of Kay (1960, pp. 282–284), with simple vagina and large, saccate seminal receptacle.

RADULA. Radula with formula of 2:1:1:1:2 and R1 radular pattern as outlined by Kay (1960, pp. 279–281). Median tooth with well-developed mesocone bordered by two smaller cusps, an equal-sized pair of denticles on base. Admedian tooth also with large central blade bordered by two small cusps but with unequal-sized pair of basal denticles. Both median and admedian teeth with subtending bracts.

Inner and outer marginals both similar, with large central blade bordered by two smaller cusps. Number of rows of teeth on radular ribbons examined ranging from 50 to 125.

Distribution.—*S. mus* is confined to an area extending from near Riohacha, Guajira Peninsula, Colombia (11°30'N, 72°45'W) (Kaufmann and Götting, 1970, pp. 362–365), into the Gulf of Venezuela, as far as Amuay Bay, on the Paraguaná Peninsula (11°35'N, 70°15'W) in depths from the intertidal zone to 5 m.

Ecology.—*S. mus* is one of the more conspicuous components of the widespread *Thalassia* community that characterizes the Gulf of Venezuela region (Petuch, 1976, p. 324). An herbivorous species, *S. mus* feeds almost exclusively on *Thalassia*. Stomach contents of ten specimens from Amuay Bay showed that the *Thalassia* was cut into oval, mouth-sized pieces that were swallowed, one after the other, like a stack of coins. Because the extensive *Thalassia* beds end both at Riohacha and at Amuay Bay, the range of *S. mus* is sharply demarcated.

Other mollusks commonly associated with *S. mus* are *Phyllonotus globosus* (Emmons, 1858), *Murex messorius* Sowerby I, 1841, *Conus punctulatus* Hwass, 1792, *Voluta musica* Linnaeus, 1758, *Chicoreus brevifrons* (Lamarck, 1822), *Chione cancellata* (Linnaeus, 1758), *Chione granulata* (Linnaeus, 1758) and *Pitar albidus* (Gmelin, 1791).

Remarks.—Dodge (1959, pp. 78–79) gave an excellent redescription of Linnaeus' type specimen of *S. mus*. From his commentary and review of the illustrations of the species by early workers, it is apparent that the type of *S. mus* corresponds to the Gulf of Venezuela morphs. This is the commonly-encountered form that has the central columellar teeth obsolete or poorly developed and with a dark brown columellar patch. Linnaeus' type locality of "ad Carthagenam" (Cartagena, Colombia) is probably in error, as the species does not extend that far south along the Colombian coast. Cartagena was the main port for ships returning to Europe from northern South America in Linnaeus' time. As a result, specimens

collected anywhere along the coast (i.e., Gulf of Venezuela) could have been interpreted as coming from the area of the port.

Siphocypraea donmoorei new species
(Figures 1D, E, G, and H)

Material Examined.—HOLOTYPE—Length 64 mm, width 42 mm, 37 m depth off Cabo La Vela, Guajira Peninsula, Colombia (12°10'N, 72°15'W), December, 1974, USNM 770731.

PARATYPES—A bulla stage, length 55 mm, 30 m depth off Cartagena, Bolivar, Colombia (10°22'N, 75°47'W), April, 1976, UMML 8162, Invertebrate Museum collection, Rosenstiel School of Marine and Atmospheric Science, University of Miami; a subadult, length 55 mm, 39 m depth off Cartagena, 23 December 1973, USNM 770732; an adult, length 61 mm, 37 m depth off Cabo La Vela, December, 1974, in my collection; an adult, length 59 mm, 40 m depth off the mouth of the Gulf of Urabá, Antioquia, Colombia (8°38'N, 77°2'W), February, 1976, UMML 8161.

OTHER MATERIAL—An adult, Length 65 mm, 30 m depth off the mouth of the Gulf of Morrosquillo, Sucre, Colombia (9°31'N, 75°41'W), February, 1976; an adult, length 55 mm, 30 m depth off Cartagena, 23 December 1973; adult specimens, lengths 61 mm, 60 mm, 60 mm, 58 mm, 57 mm, 52 mm, and 50 mm, 37 m depth off Cabo La Vela, December, 1976, all of these taken by Colombian commercial shrimp boats; a fragment, length 35 mm, and a bulla stage, length 33 mm, 15 m depth off Limon Bay, Colón, Panamá (9°22'N, 79°55'W), 23 July 1966, UMML 30-7357, from station P-451, Cruise P-6608 of the R/V PILLSBURY, University of Miami.

Shell Description.—Oval, solid, with highly arched dorsum. Base and margins rounded. Aperture narrow, arcuate; anterior canal narrow, recurved. Columellar and labial teeth well-developed, holotype with 17 columellar and 22 labial teeth: all teeth dark chocolate-brown, paler inside apertural region. Upper surface of shell pale cream-color overlaid with pale blue cloudings and numerous close-packed tan spots. Some spots fusing to form parallel bands radiating out from mid-dorsum. Dorsal line prominent, bordered by two rows of scattered blue and dark brown spots. Base of shell tan with darker mottlings; mottlings on the outer lip form dark bands extending from each labial tooth to edge of margin. Most specimens with large, bright orange columellar patch. Interior of aperture white. Dorsal tuberosities, usually two or three, on many specimens. Holotype with two large, whitish protuberances on either side of dorsal line.

Dimensions of Holotype.—Length 64 mm, width 42 mm.

Description of Soft Parts.—HEAD. Entire cephalic region and tentacles pure white (Fig. 2G). Eyes darkly pigmented and reduced in size, averaging 0.5 mm in diameter. Eyes consolidated into the bases of very elongate tentacles.

MANTLE. Pure white with occasional small pale grey mottlings near the mantle margins (Fig. 2B). Papillae white, dendritic and well-developed, averaging 6 mm in length (Fig. 2H). Several rows of smaller darkly-pigmented, club-shaped papillae lining the mantle margins.

FOOT. Broad, smooth, pure white. Dorsal margin of foot non-papillate.

GENITALIA. Female genitalia of the *Cypraea mauritiana*—type, with large, bulbous seminal receptacle, like that in *S. mus*.

RADULA. Radular formula and general radular pattern like that of *S. mus*. The mesocone of the median tooth and the central blades and side cusps of the ad-median and marginal teeth, however, are conspicuously more enlarged than those of *S. mus*.

Type.—USNM No. 770731.

Type Locality.—37 m depth off Cabo La Vela, Guajira Peninsula, Colombia (12°10'N, 72°15'W).

Distribution.—*S. donmoorei* ranges from offshore of Colón, Panamá (9°N, 80°W), along the entire northern Colombian coast to the mouth of the Gulf of Venezuela near the Monges Islands (app. 12°30'N, 70°50'W), at depths of 30 to 70 m on the preferred substrate.

Ecology.—*S. donmoorei* is a carnivorous species, feeding on various types of sponges on offshore banks. This niche is the same as that occupied by members of the sponge-eating South Australian *Zoila* complex of cowries (Wilson and McComb, 1967, p. 457, and Wilson and Summers, 1966, pp. 3–5). The stomach contents of a specimen of *S. donmoorei* from off Cartagena were made up entirely of calcareous triaxon spicules and spongin fibers. Specimens from the Gulf of Urabá (Darien) region of Colombia are associated with the "Touch-Me-Not" sponge, *Neofibularia*.

Other mollusks commonly found with *S. donmoorei* in offshore communities are *Conus lemniscatus* Reeve, 1849, *Conus castaneus* Kiener, 1848, *Conus granarius* Kiener, 1848, *Conus lorenzianus* Dillwyn, 1817, *Conus centurio* Born, 1778, *Voluta virescens* Lightfoot, 1786 (areas south of Santa Marta, Colombia only), *Fusinus closter* (Philippi, 1851), *Murex donmoorei* Bullis, 1964, *Murex olssoni* Vokes, 1967, *Ancilla glabrata* (Linnaeus, 1758), *Aequipecten linki* Dall, 1926, and *Adrana gloriosa* (A. Adams, 1855).

Etymology.—The new species is named in honor of Dr. Donald R. Moore, Division of Marine Geology and Geophysics, Rosenstiel School of Marine and Atmospheric Science, University of Miami, who has been a great source of inspiration to me in the studies of molluscan systematics and ecology.

DISCUSSION

Comparison of the Ecologies of S. mus and S. donmoorei.—The effluent of the Magdalena River and the strong winds characteristic of the northern South American coast contribute large amounts of suspended particulate material to the continental shelf waters. In these murky water conditions, which probably have existed since the Pliocene, *S. donmoorei* lives in perpetual low light levels. Living at depths greater than 30 m, *S. donmoorei* is an abundant member of offshore sponge bank communities.

Siphocypraea mus, on the other hand, has evolved as a dominant component of the inshore *Thalassia* community that occurs near Lake Maracaibo. Besides living in brightly illuminated shallow water areas, *S. mus* is often exposed at low tide to desiccating desert winds.

Comparison of the Shell Morphologies of S. mus and S. donmoorei.—Shell pattern, coloration, shape, and form have always been conservative characters in *Siphocypraea*. Well preserved specimens of Neogene fossil forms show color patterns similar to the two living species (Woodring, 1959, Pl. 31). Distinct differences in shell morphologies, however, do exist, and these readily allow for the separation of *S. donmoorei* from *S. mus*.

1) The shell coloration of *S. donmoorei* is paler than that of *S. mus*, some specimens being a uniform tan, with only a few dorsal spots. The dorsal spotting of *S. mus* is more ornate and concentrated than that of *S. donmoorei*. In *S. mus*, these spots often coalesce into large cloudings that cover the entire dorsum. In the new species, the dots, if present at all, generally remain isolated from each

Table 2. *S. mus* and *S. donmoorei*; Differences in Shell Morphology

Character	<i>Siphocypraea donmoorei</i>		<i>Siphocypraea mus</i>	
	Range and Mean	N	Range and Mean	N
Columellar Dentition (Numbers of teeth)	16-16.5-17	13	7-9.5-11	17
Labial Dentition (Numbers of teeth)	20-21.2-22	13	15-16.4-19	17
Shell Length (in mm)	50-58.1-65	14	32-40.6-53	20
Shell Width (in mm)	31-36.2-42	14	20-28.7-35	20
Shell Length/Shell Width	1.54-1.6-1.6	14	1.5-1.41-1.6	20

other and seldom fuse. *S. donmoorei* frequently has blue patches on the dorsum; this coloring is absent in *S. mus*.

2) The shapes of the apertures of the two species are distinct from each other; the aperture of *S. donmoorei* is uniformly narrow throughout and is arcuate. The aperture of *S. mus* is narrow at the posterior end but flares at the anterior end and is straight or only slightly curved.

3) The anterior canal and beak regions of the two species differ greatly; the anterior canal of *S. donmoorei* is narrower than that of *S. mus*, with the beaks closer together. The canal of *S. donmoorei* curves sharply to the left, following the line of the curved aperture. The canal of *S. mus* is straight.

4) The most prominent difference between the two species is in the aperture dentition (Figs. 2C and F). This is summarized as follows:

a) The columellar teeth of *S. mus* are poorly developed or absent in many specimens. When absent, as in roughly 50% of the specimens examined, they are replaced by a dark brown or black columellar blotch. The columellar teeth of *S. donmoorei* always form a complete row and extend well into the apertural region. Those of *S. mus*, if present, only outline the columellar margin.

b) The labial teeth of *S. mus* are flattened and form a sharp-edged border along the lip. Those of *S. donmoorei* are well-developed, sharp-edged, and curl into the apertural region, giving the shell the characteristic heavy-lipped appearance.

Comparison of Juvenile Stages.—The differences in the shell morphologies of the bulla stages of *Siphocypraea* are more apparent than those in the adult forms.

1) The bulla of *S. donmoorei* has a distinctive color patterning of well-defined dark purple-blue zigzags on a white background (Fig. 1F). These are evenly spaced around the body whorl. The bulla of *S. mus* is dark chocolate with indistinct pale flammules at infrequent intervals on the body whorl (Fig. 1C). There was no variation from this basic color pattern in several hundred *S. mus* in the bulla stage seen crawling about at low tide at Amuay Bay, Venezuela (Petuch, 1976, p. 324).

2) In the late juvenile-subadult stage of *S. mus*, the columellar teeth are poorly developed or absent. Juveniles of a comparable stage of *S. donmoorei* have well-developed columellar teeth. The thickening of the outer lip characteristic of the new species has already become apparent at this stage.

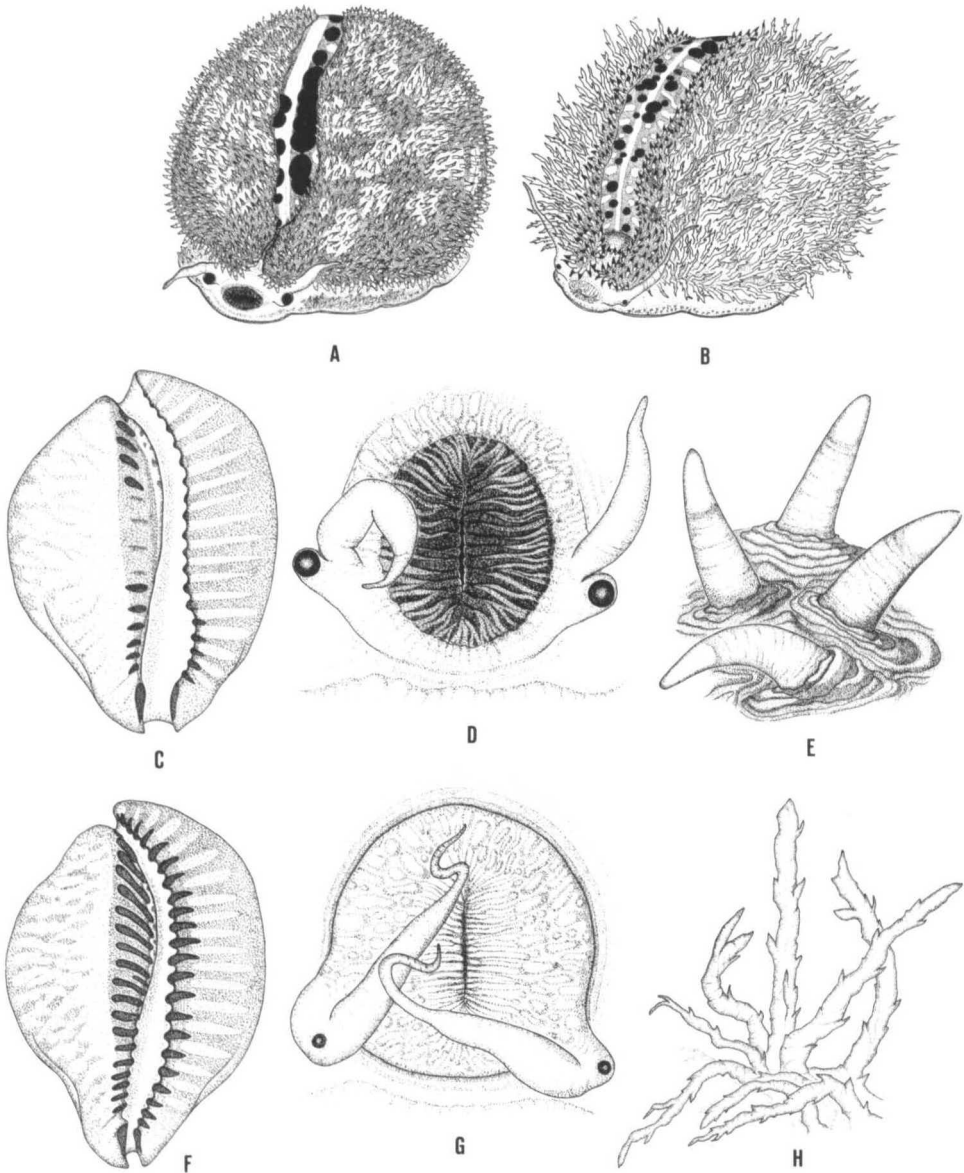


Figure 2. A, *Siphocypraea mus*, live animal, length 48 mm; B, *Siphocypraea donmoorei*, live animal, length 62 mm; C, *Siphocypraea mus*, ventral aspect with apertural teeth emphasized; D, *Siphocypraea mus*, detail of head; E, *Siphocypraea mus*, detail of mantle papillae of preserved specimen; F, *Siphocypraea donmoorei*, ventral aspect with apertural teeth emphasized; G, *Siphocypraea donmoorei*, detail of head; and H, *Siphocypraea donmoorei*, detail of mantle papillae of preserved specimen.

Comparison of Soft Parts.—The differences in the ecologies of the living *Siphocypraea* are reflected in their anatomies. Obvious characteristics that can be used to separate *S. mus* from *S. donmoorei* include:

Mantle Structure.—*S. mus* has a darkly pigmented mantle with reduced, uniformly-sized, conical papillae. These papillae generally are grey, with orange tips.

S. donmoorei has a pure white mantle with two types of papillae: pure white, elongate, dendritic papillae that cover most of the mantle, and short, club-shaped, darkly-pigmented papillae that border the leading edge of the mantle.

Head Region.—*S. mus* has a darkly pigmented head and buccal mass with large, well-developed eyes, and short, stubby tentacles. *S. donmoorei* has a pure white head and mouth region, very small, reduced eyes, and elongate, well-developed tentacles.

Dorsum of Foot.—In *S. mus*, the dorsum is darkly pigmented and covered with papillae like the mantle, while in *S. donmoorei* the dorsum is pure white and smooth.

Radula.—Though similar in general form, as expected in two closely-related species, the radulae of the two cowries do differ upon close examination. The cusps and blades of the median and admedian teeth of *S. donmoorei* are larger and more developed than those of *S. mus*. The teeth of *S. donmoorei* are also more curved than those of *S. mus*, probably reflecting the new species' sponge diet.

CONCLUSIONS

By the middle of the Pliocene, the *Siphocypraea henekeni* complex was virtually extinct in the Caribbean. The last known member of the species group occurs in the upper Pliocene Cabo Blanco Formation of Venezuela (Weisbord, 1962, p. 238). Though referred to as a variety of *S. henekeni* by Weisbord, this undescribed cowrie exhibits characteristics of both *S. mus* and *S. donmoorei* and appears to be their direct ancestor.

At the end of the Pliocene, and with the beginning of the glacially-induced sea level fluctuations, the single ancestral *Siphocypraea* had been ecologically divided into two separate gene pools. These gave rise to related species, one confined to shallow water grass beds and one to offshore, deeper water areas.

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